TOP3–00162

PMR–15 Layered Silicate Nanocomposites

Technology

The National Aeronautics and Space Administration (NASA) seeks to transfer technology for the development and production of PMR–15/layered silicate nanocomposites. Layered silicates have quickly become recognized as a useful filler in polymer matrix composites. Their platelet morphology and high aspect ratio results in greatly improved thermal, mechanical, and barrier properties.

Benefits

- Increased polymer lifetime
- Enhanced strength and elastic modulus
- Improved polymer barrier properties
- Affordable
- Does not require modifications to existing polymer processing procedures
- Not limited to PMR–15 as matrix polymer

Commercial Applications

- Aerospace: engine components and cryogen storage tanks
- Food storage/beverage containers
- Fuel cell storage tanks for automobiles and aircraft

Technology Description

Polymer-silicate nanocomposites have been an attractive means of improving matrix resins in carbon-fiber-reinforced composites. Organic modification of the silicate aids dispersion into the polymer matrix and provides a strong interaction between the clay and the matrix. The dispersion of the layered silicate clay improves the stability as well as the stiffness, strength, and barrier properties of polymers, without altering current processing techniques.

PMR–15 is a commercially available, highly crosslinked, thermally stable thermosetting polymer with excellent processability, mechanical properties, and thermal oxidative stability. PMR–15/silicate nanocomposites were investigated as a matrix material for carbon-fabric-reinforced composites and has resulted in improvements of the physical properties. Dispersion of the organically modified layered silicate into the PMR–15 matrix enhanced the thermal oxidative stability by up to 25 percent, after aging at 288 °C for 1000 hours. Mechanical properties such as the flexural strength, flexural modulus, and interlaminar shear strength were all increased by up to 30 percent.

The enhanced barrier properties of the polymer-clay hybrid are believed to slow the diffusion of oxygen into the bulk polymer, thereby slowing oxidative degradation of the polymer.

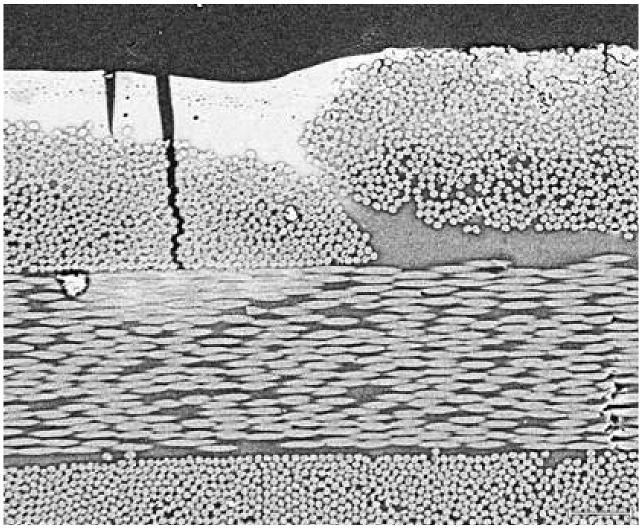

Figure 1.—Neat resin matrix composite (aged 500 hours at 288 °C).

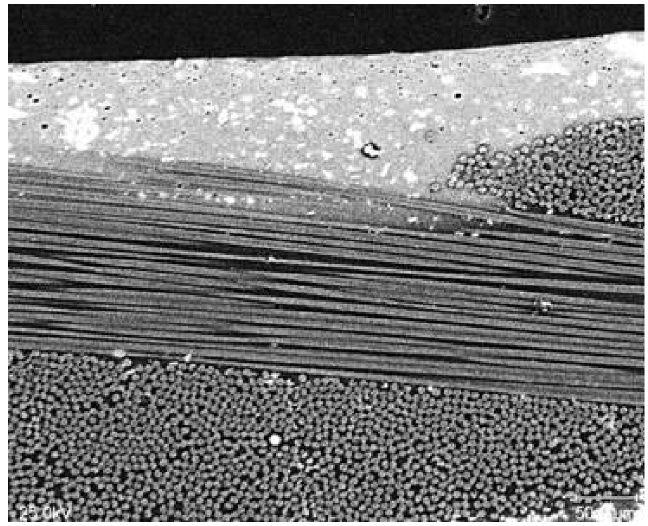

Figure 2.—Nanocomposite matrix composite (aged 500 hours at 288 °C).

Electron backscattering images show cracking of a neat resin matrix composite (fig. 1) in comparison to a nanocomposite matrix composite (fig. 2).

The images show that the dispersion of the silicate into the matrix resin reduces polymer oxidation during aging and reduces the amount of cracking in the matrix significantly.

Options for Commercialization

NASA Glenn Research Center is interested in working with industry and academia to further develop this material technology and cooperatively develop new applications for PMR–15/silicate nanocomposites.

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References

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Key Words

Nanocomposite

Polyimide

Polymer Matrix Composites

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